FINAL REPORT FOR NAGW-3429
"The Physics of Flaring Atmospheres"

Principal Investigator:

George H. Fisher
Space Sciences Laboratory # 7450
University of California
Berkeley, CA 94720-7450

The objective of our research project was to characterize the structure of the solar atmosphere during flares, to develop diagnostics of the flare from the observed radiation fields, and to better understand the origins and release of solar flare energy. Personnel involved in the research included UCB Graduate Student Mark Linton, and Research Physicists Dr. D. Tod Woods, Dr. Dana W. Longcope, and Dr. George H. Fisher. Dr. Longcope has since accepted a new position as an Assistant Professor of Physics at Montana State University in Bozeman, although he continues to work at SSL during the Summer.

The work funded by this grant is being continued through a new grant from Goddard Space Flight Center, grant number NAG5-4181. This final report refers only to recent funding from NASA headquarters as grant NAGW-3429.

Work Completed

We have have nearly completed our comprehensive atomic physics database, intended to be used throughout Solar Physics for the analysis of spectral line data observed from the X-ray regime down to optical and infra-red energies, with a special emphasis on the details needed to treat energy transport in the solar atmosphere during flares. We have extended the amount of detail in the atomic physics models by now including *all* ionization stages of H, He, C, N, O, Mg, Si, S; we have also just completed models for *all* stages of Fe, including the difficult FeI-FeIII ion stages. The details of our state-of-the-art atomic physics package will be presented at the Solar Physics Division (SPD) meeting in Bozeman, MT this Summer. This dataset will be made publically available when we complete papers which describe the models and the results.

We developed a new technique for determining the size of coronal loops from non-imaged soft X-ray flare observations, based on measured flare rise and decay time scales. This should prove to be a useful tool which can be applied to statistical studies of large numbers of flares. We have published results from our theoretical loop length prediction with observed loop lengths measured with the SXT on Yohkoh. The results of the comparison were favorable, in that our predicted loop lengths generally agreed with those measured.

We have developed a new theoretical model of how coronal magnetic energy is stored and released during flares or microflares. In this model, we find that the motion of magnetic elements in active regions, from flux emergence or sub-photospheric flows, results in the formation of "current ribbons" in the corona connecting magnetic null points. This model makes a number of observationally testable predictions. A paper describing this work has been published in *Solar Physics.*

We are performing a series of 3-D numerical simulations of the kink mode of isolated twisted flux tubes below the solar photosphere. This work has been done as a collaboration with Dr. Russ Dahlburg of the Naval Research Laboratory. This work is motivated by the kinked appearance of "δ spot" active regions, which are responsible for the largest solar flares. We are preparing a paper describing these simulations for submission to the *Astrophysical Journal.*

Publications acknowledging support from NAGW-3429:

Fan Y. and Fisher G. H., *Sol. Phys.*, **166**, 17. (1996)

Fisher G. H., Fan Y., Longcope D. W., and Linton M. G., in *Proc. IAU Colloq. 153, "Magnetodynamic Phenomena in the Solar Atmosphere: Prototypes of Stellar Activity"*, ed. Y. Uchida, T. Kosugi, and H. S. Hudson, Kluwer: Dordrecht, 329-336 (1996).

Linton M. G., Longcope D. W., and Fisher G. H., *Ap. J.* **469**, 964. (1996)

Longcope D. W. *Sol. Phys.* **169**, 91. (1996)

Metcalf T. R. and Fisher G. H. *Ap. J.* **462**, 977. (1996)

Woods D. T., Castor J. I., Klein R. I., McKee C. F., and Bell J. B. *Ap. J.* **461**, 767. (1996)